AMENDMENTS TO THE DRAWINGS:

The attached sheet of drawings includes changes to Fig. 9. This sheet, which includes Fig. 9, replaces the original sheet including Fig. 9. In Fig. 9, a clearer drawing is provided with reference numerals and lead lines.

Attachment: Replacement Sheet

REMARKS

Claims 96-133, 136-140, 142-162, 168-192 are pending; claims 96, 97, 103-106, 108-111, 113, 114, 118, 119, 121, 122, 127, 133, 136, 153, 157, 159, 160, 171-184 and 192 have been amended by the present amendment; and claims 99-102, 105-106, 127-131, 133, 136--140, 142-162 and 168-190 have been withdrawn by the present amendment.

Information Disclosure Statement

The Examiner returned an initialed copy of the PTO Form 1449 from the First Information Disclosure Statement which applicants submitted. However, on the initialed copy, two references are not initialed -- FR 2,757,499 (which corresponds to USPN 6,245,309) and WO 03/027005. The Examiner is respectfully requested to consider these references and return an initialed copy of the PTO Form 1449 from the First Information Disclosure Statement indicating such.

Drawings

The drawings are objected to under 37 CFR § 1.83(a) because Figure 9 allegedly fails to clearly show the outlet electrode has no opening towards the center whilst this is the case for the inlet electrode as described in the specification. The Examiner has requested a corrected drawing sheet. Applicants submit herewith a Replacement Fig. 9 that shows with greater clarity the inlet and outlet electrode systems. Entry and consideration of the Replacement Fig. 9 is respectfully requested. Accordingly, the drawing objection is respectfully requested to be withdrawn.

35 USC § 112

Claims 96-98, 103, 104, 107-126, 132 and 191-192 stand rejected under 35 USC § 112, second paragraph as being indefinite. Specifically, the Examiner rejects the use of "conductive filling material" in place of "conductive lining material." Applicants traverse this rejection. However, in order to advance prosecution, applicants have amended the claims to recite "conductive lining material." Applicants respectfully assert that this amendment does no change the claim scope. The issue of "filling" compared to "lining" results from a translation issue. The original French term is "garnissage" and is meant to refer to, for example, a material which is placed in the space between the disks of the electrodes, and not a material which is deposited on the disks in the form of a more or less thick coating.

Accordingly, applicants have amended the claims to recite a "conductive lining material" with the intention of such material being, for example, a material which is placed in the space between the disks of the electrodes, and not a material which is deposited on the disks in the form of a more or less thick coating.

Entry and consideration of the amendment and withdrawal of the § 112, second paragraph, rejection is respectfully requested.

Art Rejections

Claims 96-98, 104, 107-11, 113-115, 117-122, 132, 191, and 192 stand rejected under 35 USC § 103(a) as being unpatentable over Mallison (USPN 6,159,432) in view of Fletcher (USPN 3,771,959), Predtechensky (USPN 6,846,467) and Maskalick (USPN 4,447,509). Further, claims 103, 111, 112, and 123-125 stand rejected under 35 USC § 103(a) as being unpatentable over Mallison (USPN 6,159,432) in view of Fletcher (USPN 3,771,959) and Pevere (USPN 2,858,261).

Further, claim 116 stands rejected under 35 USC § 103(a) as being unpatentable over Mallison (USPN 6,159,432) in view of Fletcher (USPN 3,771,959) and Predtechensky (USPN 6,846,467). Finally, claim 126 stands rejected under 35 USC § 103(a) as being unpatentable over Mallison (USPN 6,159,432) in view of Fletcher (USPN 3,771,959) and Hoecker (USPN 6,615,588). Applicants respectfully traverse these rejections.

As clarified by the present amendment, the presently claimed invention relates to an electrically assisted catalytic ohmic heating reactor. The Official Action of 5 March 2009, does not appear to appreciate the ohmic nature of the presently claimed invention and does not present a *prima facie* case of obviousness.

Applicants discuss below each applied reference in brief, and then the asserted combinations.

Mallinson

Mallison discloses an apparatus and a method for converting a gas stream containing hydrocarbons.

The apparatus comprises a housing 20, which may be made of a conductive material with a non-conductive coating on the interior surface 21, a reaction zone that is spaced within the housing 20 between a first electrode 30 and a second electrode 40, a catalyst material that may be disposed on one of the electrodes, devices for entering the gas mixture in the apparatus and for the exit of the resulting products, and a power source connected at least to one of the electrodes.

The catalyst material is a material capable of modifying the reaction of the gas stream containing hydrocarbons ***with a plasma discharge*** (column 3, line 67 –

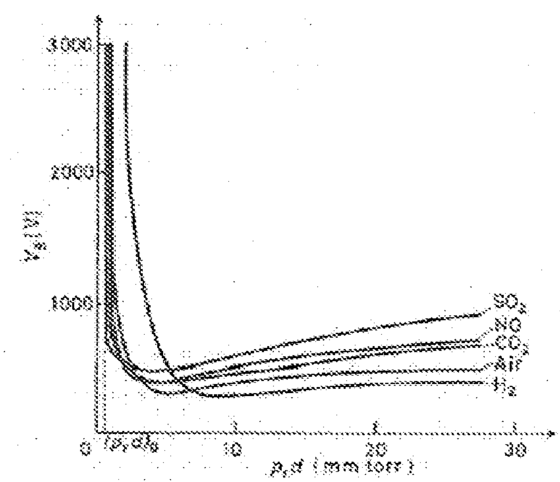
column 4, line 1). A list of materials is mentioned (column 4, lines 2-14) which are all non conducting dielectric materials.

The apparatus further comprises means for producing a ***plasma discharge*** between the electrodes (column 4, lines 33-56).

The method for converting a gas stream containing hydrocarbons is implemented in the above apparatus, and comprises a step 2) of producing a plasma discharge (cold plasma) between the electrodes. The plasma discharge converts the hydrocarbons.

Plasma is the fourth state of matter. The plasma discharge is generated by the application of an electric field between two points. The mechanism of discharge plasma production is clearly explained column 10, line 19 – column 11, line 13.

It is well known in the art that discharge plasma is produced by applying a high electric field, generally higher than 600 V/cm. This is clearly shown by Paschen curves, which give the breakdown voltage vs. pressure for gases. See Kettani M.A. et Hoyaux, M.F, Plasma Engineering, John Wiley & Sons, 1973, p.63). Some examples are shown on the attached figure.



As illustrated in Example 1 of Mallinson, a voltage of 5 kV is applied to electrodes. The distance between the tip of the wire electrode and the plate electrode is 10 mm. Such a design provides an electric field of about 5000 V/cm .

In the Mallinson method, the electric current between the electrodes is carried by an ionized gas. In contrast, in an electrically assisted catalytic ohmic heating reactor according to an embodiment of the claimed invention, the electric current is carried by the conducting lining material placed between the electrodes, not by plasma formation. In an electrically assisted catalytic ohmic heating reactor according to an embodiment of the claimed invention, the electric field remains very low as shown in the examples of the present specification; the electric current in the lining material results both in an ohmic heating of said material and enhancement of the catalytic activity of said material.

Predtechensky

Predtechensky discloses an apparatus and a method for reforming a gas which contains hydrocarbons.

The reactor comprises a reaction chamber, means for supplying the reaction chamber with plasma forming gas (which may be the gas to be reformed), means for removal of the end product, two electrodes each consisting of a container filled with metal (for instance iron scraps) and disposed in such a way that voltage applied between them strikes an arc discharge in the space between the electrodes, and the plasma forming gas is fed to the reaction chamber to form a vortex flow of the gas in the space between the electrodes .

Predtechensky discloses a ***thermal plasma method*** for reforming a gas. Column 5, lines 22-26 ("Plasma is a source of high temperature necessary for

chemical reaction to proceed. Small quantities of iron vapours coming from the molten electrode surface are the catalyst for the reaction rate.")

In the Predtechensky method, the catalyst is provided by iron vapours generated by the electric arc striking the metal iron surfaces of the electrodes. The catalyst is provided neither from a conducting solid material in direct contact with both electrodes, nor from the passage of electric current through the iron metal phase.

Fletcher

Fletcher discloses a method based on the Bosch reaction, which is as follows:

$$2\ H_2 + CO_2 \rightarrow 2\ H_2O + C$$

The reaction is carried out in the presence of steel wool as the catalyst, in a reactor which is not an electrical reactor. There are no electrodes.

A method described for the Bosch reaction cannot be used as a reference for a hydrocarbon gas reforming reaction. The Bosch reaction is an exothermic reaction which must be implemented at low temperatures (lower than 700°C) because at higher temperatures, the Gibbs free energy ΔG becomes negative which involves equilibrium constant K to become~~s~~ lower than 1. The evolution of ΔG and K with temperature is given in the following table.

T °C	ΔH kJ/mole	ΔG kJ/mole	K
0	-89.678	-65.072	2.785E+012
100	-91.586	-55.752	6.382E+007
200	-93.403	-45.922	1.175E+005
300	-95.084	-35.718	1.801E+003
400	-96.637	-25.230	9.077E+001
500	-98.071	-14.519	9.572E+000
600	-99.388	-3.629	1.649E+000
700	-100.583	7.405	4.004E-001
800	-101.650	18.556	1.250E-001

A hydrocarbon gas reforming reaction: $CH_4+H_2O \rightarrow CO+3H_2$, is an endothermic reaction which is preferably carried out at higher temperatures, preferably higher than 700℃ where the Gibbs free energy becomes negative, as show in the following table.

T ℃	**ΔH kJ/mole**	**ΔG kJ/mole**	**K**
0	204.723	147.245	6.918E-029
100	209.232	125.448	2.741E-018
200	213.144	102.498	4.825E-012
300	216.445	78.776	6.608E-008
400	219.172	54.523	5.872E-005
500	221.369	29.902	9.542E-003
600	223.084	5.026	5.004E-001
700	224.355	-20.022	1.188E+001
800	225.215	-45.180	1.582E+002
900	225.695	-70.401	1.364E+003
1000	225.838	-95.648	8.406E+003

Steel wool as a lining material could not be used to form a discharge plasma from a gaseous mixture, according to Mallinson. The reason steel wool would not be used in as a lining material in the plasma of Mallinson is because steel wool is electrically conductive and it would not allow intensive electric field required for plasma discharge. Regardless, Fletcher discloses a reactor which is equipped neither for plasma discharge, nor for ohmic heating of a material. According to Fletcher, the gas mixture to be treated is heated by an electric heater. But the steel wool is not heated by submitting it to voltage drop.

Asserted Combination

From the above, it is clear that the presently claimed invention cannot be considered as obvious in view of the prior art Mallinson, Fletcher and Predtechensky. Mallinson and Predtechensky both disclose a method involving plasma carried out in an electric reactor having two electrodes. Both cold plasma (according to Mallinson)

and hot plasma (according to Predtechensky) need high electric field between the electrodes. One skilled in the art would not modify Mallison (or Predtechensky) to incorporate a porous conductive lining material due to the need for a high electric field for plasma creation.

Thus. the Official Action errs in asserting that the present invention is similar to the Mallinson method wherein only the dielectric material between the electrodes has been changed to a conducting material.

Moreover, one skilled in the art would not modify the Mallison method to incorporate the steel wool from Fletcher. Mallinson relates to a plasma method and the Fletcher method is a mere chemical method not implemented in an electric generator.

The Examiner is reminded that the presently claimed invention, as set forth in representative claim 96, is an electrically assisted catalytic ohmic heating reactor with a porous conductive lining material. The conductive lining is heated by an electronic flux generated between the electrodes. This enables multiple functions: the conductive lining allows electric charges to be transferred from one electrode to the other; the conductive lining is heated, which supplies the energy required for endothermic reactions; and the electron flow enhances the catalytic function of the conductive lining material.

In contrast, both Mallinson and Predtechensky reactors are reactors equipped with means capable of producing plasma discharge. Mallinson produces cold plasma discharge, which is directly related to the use of non-conducting dielectric lining materials. Predtechensky produces hot plasma discharge created by means capable of providing an electric arc between the electrodes.

Fletcher discloses a method for treating a gas mixture based on a Bosch reaction which is not a reforming reaction and which needs operating conditions fundamentally different to those for gas reforming.

It is clear that one skilled in the art would not combine the features of Mallinson, Predtechensky and Fletcher to arrive at an electrically assisted catalytic ohmic heating reactor.

Maskalick and Hoecker do not remedy the deficiencies of the above asserted combination.

Accordingly, the present rejection is respectfully requested to be withdrawn.

Conclusion

For at least the reasons stated above, the Examiner is respectfully requested to reconsider and withdraw the outstanding rejections and objections, and to allow the present application.

In the event that there are any questions concerning this amendment, or the application in general, the Examiner is respectfully urged to telephone the undersigned attorney so that prosecution of the application may be expedited.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date: <u>5 June 2009</u> By: T.D. Boone

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